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The Uredo-stage of Gymnosporangium.

H. M. RICHARDS.

(WITH PLATE XVII.)

In the *Botanische Zeitung* for June 22, 1888, there appeared a paper by Kienitz-Gerloff entitled, "Die Gonidien von Gymnosporangium clavariæforme," in which he describes the presence of two forms of spores in the gelatinous fruit mass of that fungus. Although both are two-celled and of about the same size, they may, he says, be easily distinguished. Those found on the inside of the spore mass are symmetrical, having thin hyaline walls and finely granular contents, while on the other hand the spores more generally present on the outside are not symmetrical, the upper cell being much blunter than the lower one. Their walls are dark brown and more than twice as thick as those of the first form, and their contents are not granular. It is in their method of germination, however, that he sees the most important distinction. The thick-walled spores always send out promycelia of the form which is characteristic of teleutospores. In the thin-walled spores it is entirely different. In these he observed two cases where the end of the spore grew out in a tube, the contents of which did not divide up into cells and bear sporidia, but remained unbroken, resembling in this the method of germination characteristic of uredospores. He also noticed a singular fact, that, instead of the endospore penetrating the exospore as is usual, the whole end of the spore grew out without rupturing the exospore.

From their general dissimilarity in shape and structure, and from their peculiar method of germination, he concludes that these thin-walled spores represent the hitherto unknown uredosporic form of G. clavariæforme. Were their morphological characters and the method of germination constant, it would be quite possible that the thin-walled spores might represent what he claims. As the uredosporic form has not before been recognized in any of the Gymnosporangia, it seems highly desirable that the view advanced by Kienitz-Gerloff should be tested by an examination of American spec-

imens. That there are two forms of spores in G. clavariæforme and also in other species has been known for a long time. Among the more important references are those of Oersted,[1] who figures both kinds of spores in the case of *G. clavariæforme*, of Rees,[2] in *G. fuscum* and *G. conicum*, of Körnicke,[3] and also of Farlow,[4] and further search would doubtless show other refer ıces. Although, as I have just said, the existence of two forms of spores was well known to writers before Kienitz-Gerloff, no particular significance was attached to the fact and they were both considered as forms of teleutospore produced by difference in exposure or time of development.

That the conditions of my work might be as nearly as possible like those of Kienitz-Gerloff, and the results readily compared with his, I took G. clavariæforme, the species used by him in his investigation. As it is quite common on the Juniperus communis in the neighborhood of Boston, I had no difficulty in getting all the material I wanted. That which I used was obtained from Saugus through the kindness of Mr. Seymour. It was collected on the 11th of April, and being at that time still young the spore masses had scarcely appeared on the bark of the Juniper, but it was easily ripened when kept for a short time under a bell-glass in a moist atmosphere. At the time the first observations were made the young spore-masses were only slightly convex and had not swelled to the conical form attained at maturity. At this stage sections across the spore-mass show that all the spores resemble each other closely, being long and fusiform, and no distinction can be made between the blunt thick-walled and the acute thin-walled spores.

When mature differences in the spores are seen. One kind, which is found in the inner portion of the spore-mass, is composed of two acutely conical cells which are joined at their bases, making a long, symmetrical, fusiform, or lanceolate spore (fig. 1); the other is commonly met with nearer to the periphery and consists, like the first, of two cells, but is not symmetrical, the upper cell being quite blunt and rounded off, thus making the spore clavate in form (fig. 2), as is described by Kienitz-Gerloff. Both forms are of about the same size; the clavate variety being perhaps a little shorter in proportion to its width than the other; and both

[1] Bull. Acad. Roy. Sci. Copenhagen, 1867, Plates III and IV, figs. 3 and 7.

[2] Die Rostpilzformen der deutschen Coniferen, pp. 17 and 26, 1869.

[3] Hedwigia, xvi. 27, 1877.

[4] The Gymnosporangia of the U. S., 1880.

have long pedicels which are quite distinct when young, but which tend to gelatinize on the edges as they grow older, especially in the case of the fusiform spores. The thickness of the wall averages about the same in all the spores with the exception of those on the very outside. There it is usually somewhat thicker than in the others (fig. 3) and generally of a smoky-brown color. The contents are alike in both varieties, and in no way different from those of the normal *Gymnosporangium* teleutospore, consisting chiefly of a more or less granular mass, in which may be one or more orange oil-like globules and a number of vacuoles. Neither the shape nor distribution of the spores above described is definitely marked, one form gradually passing into the other, with all gradations from the most symmetrically acute variety to the more irregular obtuse one.

In order to see if, as Kienitz-Gerloff maintained, the acute spores germinated differently from the obtuse ones, I took a considerable number of both forms and studied their method of germination under like conditions.

When removed to a glass slide and kept moist with a little water, in a few hours the spores, whether acute or obtuse, produced in the region of the septum from one to three—occasionally four—promycelia of the form typical in this genus, that is, composed of short cells which produce short sterigmata-bearing sporidia (fig. 4). In some cases the sterigmata grew out to an indefinite and often considerable length without producing sporidia. If supplied abundantly with water it not unfrequently happened that, instead of ordinary promycelia, the germinal tubes grew out to a great length (fig. 5), fifteen or sixteen times the length of the spore, and the contents did not divide up, but remained continuous throughout without producing sporidia. When the spores are kept only slightly damp another peculiarity may be noticed. Instead of growing out into promycelia the germinal tubes push out a little distance into short thick filaments and then divide into four or five stout oblong cells which soon fall apart (fig. 6). Subsequently the cells which have become thus separated grow out at one or more of the angles into hyphæ. An appearance resembling such as has been described has also been noticed by Cramer[5] in the case of *G. fuscum*. The process may be still further simplified. In some cases the germinal tubes protrude a very short distance, not producing promycelia or a filament of any kind, but only

[5]Oeber den Gitterrost der Birnbaunil, etc., Schweiz, landwirth Zeit, 1876.

small bud-like cells as is seen in fig 7. Very soon these buds become separated from the spore, and after a time send out tubes, like those which come from the sporidia when they germinate. This method is seldom found among the spores on the outside, but occurs chiefly in those in the inner part of the spore-mass.

In the forms of germination already considered, it will be seen from the accompanying figures and descriptions that the promycelia arose from the region of the septum in all cases, no matter whether the spore was obtuse or acute, or, in other words, whether it was what Kienitz-Gerloff calls a teleutospore or a uredospore. We come now to other forms of germination, where the germinal tube arises from the apex of the spore instead of from the region of the septum. This method of germination was found beyond a doubt in both the acute and obtuse forms, though more frequently in the latter. In fig. 8 a spore which is clearly of the acute form is represented germinating by the end, while in fig. 9 one of the obtuse kind is shown behaving in a similar manner. This form of germination of the obtuse spores was apparently not seen by Kienitz-Gerloff. In some cases where germinal tubes were produced from the end of the spore promycelia were also found arising from the region of the septum.

The terminal promycelia grew in all respects like the others, and, with few exceptions, they all bore sporidia. No cases were seen where the germinal tubes grew out to any very great length even when the spores had been kept in an excess of water. In one case, where the spores were only kept damp, a terminal promycelium was noticed, which broke up in the same way as those arising from the septum under similar conditions (fig. 10). On two occasions germinal tubes were seen to arise from the fixed end of the spore, very near the point of attachment of the pedicel, but, except for their point of origin, the promycelia were normal.

If we now compare the results of my observations with those of Kienitz-Gerloff, it will be seen that the latter are not sufficient to warrant the conclusions which he drew from them. From both his observations and my own it is plain that the obtuse spores borne on the outside of the spore-masses are teleutospores, since, on germinating, they produce the characteristic promycelia. Apparently Kienitz-Gerloff is of the opinion that the promycelia are always produced at the septum. I have shown, however, that, although

this is the rule, it is not unusual to find the promycelia produced at the apex of the spore. Furthermore, the statement that the obtuse spores are teleutospores is not invalidated by the fact that under certain conditions the germinal tubes do not form the ordinary promycelia with sporidia, but break up into separate cells or even drop away from the spore in the shape of bud-like cells before they have developed into a filament of any kind. With regard to the fusiform spores Kienitz-Gerloff's statement is that they bear germinal tubes, which, in growing out into filaments, do not form proper promycelia with sporidia. But my observations, although they agree with those of Kienitz-Gerloff in showing that terminal germinations are occasionally to be found in the fusiform spores, yet, in the majority of cases, they germinate like the obtuse spores and bear normal promycelia and sporidia at the septum.

Since then it is the fact, as shown by these notes and the accompanying figures, that, in their mode of germination, both the obtuse and fusiform spores bear the promycelia characteristic of teleutospores, we must conclude that, if the obtuse spores are teleutospores, the fusiform spores are also teleutospores. The only ground for supposing that the latter are uredespores is the statement of Kienitz-Gerloff that they do not produce promycelia but rather the tubes found in uredosporic germination, and I have shown that this statement is erroneous, and that what he considers to be the constant form of germination in the case of the fusiform spores is really only an exceptional form of germination, which is also to be seen at times in the obtuse spores with regard to whose teleutosporic nature all writers agree. We must conclude that both the obtuse and fusiform spores are teleutospores in spite of their differences in size and shape. As already remarked G. clavariæforme is not the only species in which two forms of teleutospores are known, and for further information on this point one should consult the paper by Dietel in Hedwigia, 1889, p. 99. The mode of germination of teleutospores of Gymnosporangia is subject to a good many modifications, depending, in part at least, on the variations in the amount of moisture to which they are subjected. The modifications mentioned above, as I am informed by Prof. Farlow, at whose suggestion I undertook the examination of the subject, have been frequently seen by those who have studied this genus, although but little has been said about them in print.

EXPLANATION OF PLATE XVII.—Fig. 1. Typical fusiform spore.

Fig. 2. Typical clavate spore.

Fig. 3. Thick-walled clavate spore of the form found on very outside of the spore mass.

Fig. 4. Showing normal method of germination.

Fig. 5. Method of germination of spores in an excess of water.

Fig. 6. Method of germination of spores when damp.

Fig. 7. Simplified method of same.

Fig. 8. Fusiform spore germinating by the end.

Fig. 9. Clavate spore germinating in a similar manner.

Fig. 10. Terminal germination brought about by same conditions as in 6 and 7.

All these figures are magnified 410 diam. and then reduced one-third, except Fig. 5, which is magnified 250 diam.

Cryptogamic Laboratory of Harvard University.

Observations on the temperature of trees.

H. L. RUSSELL.

(WITH PLATE XVIII.)

During the winter and spring of 1889 experiments were conducted upon the temperatures of trees, and the following preliminary notice of some of the results obtained is given. A number of questions have arisen in the course of the experiments which will require some time to solve, and as these will have to be postponed till the next winter, it is thought best to lay the facts gained so far before those interested in these problems, and reserve the remainder for further consideration. As far as could be ascertained very few data have been collected upon the subject, and the observations are recorded, as they may possibly be of use in the future.

The experiments were conducted in the following manner: Holes one-half inch in diameter were bored into the trees at equal heights from the ground. The thermometers used were Centigrade, and were carefully compared with each other to detect any variation in graduation. The thermometers were inserted in the borings so that the base of the bulb came in contact with the wood; the space about the thermometer being packed tightly with cotton-wool.

An experiment was made upon a good-sized shag-bark hickory (Carya alba) to see to what extent the temperature of the interior of the tree followed that of the exterior. The tree was about 30 cm. in diameter, and the borings, which were on the south side, were made at the following depths, viz.: 3, 6, 10, and 12 cm. Readings were taken from the thermometers at these varying depths, and also from one placed on the north side of the tree, not in contact with the bark or exposed to the direct rays of the sun. These readings were noted at intervals of 1 to 2 hours during the day, and in a number of instances were continued through the night. The period of time embraced by the experiment was about fifteen days, and covered several days of warm weather as well as our coldest days.

The detailed readings are not given here, but the results arrived at are essentially as follows. The temperature of the tree as a general rule ranged higher than the outside, with two or three exceptions, when the air temperature was higher during the warmer portions of the day. The maximum temperature of the air was generally between 1 and 2 P. M., while the minimum ranged from 6 A. M. to 7. The following table indicates the average time of the maximum and minimum temperatures for the different depths:

	Maximum.	Minimum.
Outside.	1.00 P. M.	6.45 A. M.
3 cm. deep.	2.00 P. M.	7.00 A. M.
6 cm. deep.	4.15 P. M.	8.00 A. M.
10 cm. deep.	6.15 P. M.	9.30 A. M.
12 cm. deep.	6.45 P. M.	10.00 A. M.

It will be seen by reference to this table that the rate of conduction varies somewhat for different depths: that the heat is both absorbed and radiated more rapidly in the outer layers than in the center.

Representing the temperatures graphically, it was seen that that of the interior of the tree presented the most uniform curve, *i. e.*, one whose amplitude was the least. The mean daily variation for the outside and the shallowest boring was about 12.5° C., while that of the interior was only 7° C. Thus the average temperature of the tree, in its most central part, is not much above the temperature of the air during

the winter months. During the cold days in the early part of February, in which the thermometer fell to −22° C., we find that the interior of the tree registered only 5 degrees higher than this.

To see if there was any material difference between conifers and deciduous trees, an experiment was made with a Scotch pine (Pinus sylvestris), and a white oak (Quercus alba). The trees selected were of nearly the same diameter, and all other factors were considered, to equalize, as far as possible, the conditions of the experiment. By reference to A, plate xviii, it will be seen that in no case (where conditions were favorable for the experiment) was the temperature of the pine as high as that of the oak, with the exception of the early observations in the day. As a general rule, the observations from 7 to 10 A. M. indicated a higher temperature in the pine than in the oak. This is due to the slower radiation of the pine. It is noticeable that the temperature of the oak falls more rapidly than the pine, late in the afternoon, showing that it radiates the heat absorbed during the warmer portions of the day quicker than the pine, which is clothed with evergreen foliage.

Prof. Prentiss states that conifers have a higher specific heat than deciduous trees in winter.[1] He uses the term specific heat, not in its physical sense, but as meaning the heat evolved by metabolic processes. From the observations made here we have been unable to arrive at similar results. The temperature of the pine we found to be lower than that of the oak at all times except during the latter part of the night and early morning, and the chemical changes occurring in the stem at this season of the year are probably so slight that radiation would carry off the heat about as fast as it was produced. The period of observation for this experiment extended over the middle of March, with the temperature ranging high for this season of the year, but as yet little or no change had taken place in the interior structure of the tree. To see if heat evolved by chemical changes in the tree would be sensible to a thermometer, a comparison was instituted later in April between dead and live timber. The tree selected was a very favorable one for the experiment, inasmuch as it had one large dead branch, with bark intact, while the remaining branch was a vigorous growth. This apple tree was taken for the experiment at a time when the buds were quite well started, so that chemical

[1] 2d Rept. Cornell Univ. Exp. Stat. ('82 and '83), page 42.

action was going on vigorously at the time. The experiment was continued for ten days, but without any very definite results. The maximum of temperature alternated rather irregularly between the live and dead wood, and did not seem to give any uniform results. The causes of these rapid fluctuations are not so easy to understand, yet I think that it is extremely doubtful whether the metabolic processes involved generate sufficient heat to influence the ordinary thermometer.

We have seen above that considerable difference was found between evergreens and deciduous trees like the oak. To see if this same difference was apparent between evergreen and deciduous conifers, an experiment was tried with the pine (Pinus sylvestris) and the European larch (Larix Europæa). The results obtained are shown in B, plate xviii. They indicate that the temperature of the larch and oak were very nearly the same. As a general rule the temperature of the larch was above the pine during the greater part of the day, the reverse being true for the night and early morning. There is not any very great difference in the structure of the wood of the larch and pine, so that this difference can not be attributable to this cause. It seems to lie in some other direction.

Comparative observations were made with the pine, larch, oak, poplar, and outside air, and in all cases the temperature of the pine was found to be considerably lower than any of the remainder, with the exception mentioned. To what, then, is this lower temperature due? Presumably the thick coating of foliage on the pine exerts a considerable influence upon it, as it would seem to have a tendency to prevent absorption of heat by the trunk, and would very likely interfere with radiation to some extent.

In order to see what influence the foliage had upon the temperature of the trunk, the following experiment was made: Two balsam firs (Abies balsamea) were chosen, that were as nearly like each other as possible, and the temperatures of their trunks were compared with each other for a time, to see if any material difference existed between the individual trees. The foliage of this tree presents a compact surface, and was thus better adapted for the experiment than the pine. After a short period of comparison between the two trees, one of them was stripped of its foliage for a distance of several feet above the thermometer, and comparative readings were then taken, to see what influence denudation of foliage exerted upon the temperature of the trunk.

In C^1, C^2, Plate xviii, *a* represents the fir which was later stripped of its branches; *b* the one that was used for a control experiment. The slight difference between *a* and *b* in C^1 may be attributable to the more exposed position of *a*, and also to the less compact condition of the lower branches. C^2 shows the temperatures of the two trunks after the branches had been removed from *a*. It will be seen that the greatest variation before stripping was only about 1° C. (see C^1), while there was often a variation of 4–5° between them after the branches had been removed from *a*. It is also noticeable that the temperature of the stripped tree begins to fall more rapidly, and that as a rule it was lower than *b* in the morning. These results point quite conclusively to the fact that the thick coating of foliage which surrounds the trunk accounts, to a large extent, for the lower temperature of evergreen conifers, and that absorption and radiation go on at a much more rapid rate where trees are not provided with winter foliage.

To see if any material difference existed between the temperatures of woods of different densities, an experiment was first made between a shag-bark hickory (Carya alba) and a cultivated crab-apple tree. The hickory was somewhat the larger of the two trees. The specific gravities of the trees show a difference of .1324, the hickory being 0.8372, and the Pyrus 0.7048.[2] The borings were made to a depth of 10 cm., and readings were taken for a period of about ten days, but no very great difference was recorded in the temperatures. It may be noted in this connection that there was no very great difference in the character of the bark, as the bark of the hickory had not begun to exfoliate very much. Another trial was made with a poplar (Populus grandidentata) and a white oak (Quercus alba). Here the difference in density is much more marked, the specific gravity of the poplar being .4632, while that of the oak is .747, a difference of over 50 per cent.[2] The borings in this case were not made so deep, in order to see how great a difference existed in the outer layers of the wood proper. The course of these temperatures, as drawn in diagram D, plate xviii, shows that the soft wood was far more variable than the denser wood. Not only was the temperature of the poplars considerably higher during the warm part of the day, but it sank from 1–2° below that of the Quercus during the night. The range in variation of the poplar averaging about 16.5° C. per day, while

[2]Report Tenth Census. Sargent: Forest Trees of N. A.

that of the oak was 12.5°. The temperature of the oak remained about the same as the air temperature, while the poplar was often 5° higher during the heat of the day.

The question naturally arises, what causes the difference in temperature between these trees? Does it exist in the different densities of the two woods, or can it be assigned to some other cause? There are several sources to which we might look to find the cause. The different densities of the woods, the heat evolved by chemical changes in the tree, the color and texture of the bark, causing different degrees of absorption, might be suggested as possible causes. It is more than likely that more than one of these possible causes are involved.

If we compare the temperature of the larch and oak, we find that although quite a difference exists between their specific gravities, but little difference is found in their temperatures. The difference in their specific gravities is .1234 or about 20 per cent., while the difference in the mean daily temperature for the length of the experiment does not exceed $\frac{3}{4}$° C. This evidently does not furnish a satisfactory reason for the difference in temperature. The difference in the absorptive powers of different colors is well known, but here I think it plays but a small part. The poplar used for the experiment was covered with a smooth greenish-gray bark, while in the oak the bark was roughened and darker gray in color. The darker the color, the greater the amount of heat absorbed, would lead one to think that the temperature of the oak ought to be higher than the poplar, but such was not the case, so that we must seek still farther for a cause.

Heat due to chemical changes, if sensible to the thermometer, might produce some difference, as the metabolism of the poplar was probably greater at this time than in the oak. But from the experiment conducted upon living and dead timber with the apple tree, it is hardly possible that this would account for the considerable difference that existed between these two trees. The influence of the bark upon absorption plays, I think, a far more important part than either of the above. It was seen that the oak and the larch differed but little in respect to temperature, and here we find quite a similarity in the texture and character of the bark. Both are of a neutral gray tint and are more or less roughened, although scarcely corrugated. To test the influence of the bark upon the temperature, two trees were taken of the same species (Populus grandidentata), but with bark of different character.

One of the trees had a close, smooth bark, and the other a thicker, rough, corrugated bark. There was considerable difference in the diameter of the two trees, the smooth one being about 16 cm., and the rough one about 28 cm. in diameter. To eliminate the influence of this difference in volume as much as possible, the borings were made on the south side of the tree to the depth of 6 cm. Reference to diagram E will show the temperatures of the two trees. *a* indicates the rough barked, and *b* the smooth barked poplar. On some days there was a difference of 6 to 10 degrees in the temperatures, the smooth barked tree being the warmer. It was noticeable that on cloudy days, as were the 17th and 18th, that the variation was not so marked. Although the larger volume of *a* would have a tendency to lower its temperature, yet it hardly seems possible that anything like this difference would be caused on this account.

Lack of time at present, prevented further experiments being made upon this point, but the above results point, I think, toward the conclusion, even if they do not warrant us in stating positively that the direct absorption of heat is the main cause of the higher temperature of trees, and that it is largely dependent upon the character of bark.

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EXPLANATION OF PLATE XVIII.—Vertical scale 1° C.=.1 inch. Horizontal scale, 12 hrs.=.6 inch. A, Showing difference in temperature between evergreen and deciduous trees. B, Showing difference in temperature between evergreen and deciduous conifers. (Period from 16th to 19th indicates continuous rainy weather.) C, Influence of denudation of foliage upon temperature of conifers. C^1, Before stripping off foliage from tree. C^2, After stripping off foliage from tree; *a*=tree that was stripped; *b*=tree used for control experiment. D, Showing difference in temperature between woods of different densities compared with temperature of the air. E, Showing difference in temperature between two trees of the same species, with bark of different nature.

Paraguay and its flora. I.

THOMAS MORONG.

Land of heat probably most people in the Northern United States would say, if they thought of it at all. True enough, for the mercury in the Fahrenheit thermometer hanging in

my room averaged from November 1 to the middle of April 80° night and day, and sometimes rose to nearly 100°, while in the sun out of doors it easily marked 110°. Even now (July) in the month corresponding to our January, it stands much of the time at 65° and 68°, and has only occasionally fallen as low as 40°. Land that rarely knows a slight frost, in which stoves are nearly unknown, where the windows are generally without glass, where the country people sleep and almost literally live out of doors; land of the most delicious atmosphere to one who likes warmth as well as I do; where rheumatism, neuralgia, consumption and their kindred diseases seldom occur; land that for these very reasons possesses a rich and varied vegetation, it is necessarily a land full of surprises and of rare interest to a botanist from a colder climate. Around him, with trunks tall and straight as a column, and with their graceful, drooping fronds rustling in the slightest breeze, stand several species of that monarch of the floral world, the palm. The most common species about Asuncion, popularly called the "Coco" or "Pindo," is the Cocos australis, which rises to the height of thirty or forty feet. This tree bears a true cocoa-nut, about the size of a marble, an inch and a half in diameter. I could hardly believe it to be a cocoa-nut until I split one of the fruits in two and ate the contents. The meat is as good as that of its larger brothers for aught that I can see. It yields an excellent oil, and is often here ground and pressed in mills for that purpose. The foliage furnishes a very good fodder for cattle, and is occasionally used for thatching roofs. No boys, however, would venture to climb the tree in order to get the fruit, for the trunk is armed over its whole length with long, sharp thorns, some of them at least five inches in length, wounds from which are said to fester in the flesh. Two other species of the palm are common in Paraguay, the Cocos sclerocarpa, similar to the Pindo, but with a smooth trunk, and a smaller-sized tree which has nearly erect, fan-shaped leaves, and bears a large panicle of small berries (Livistona?). Across the river Paraguay, in the territory known as the "Gran Chaco," another and a very different species, known as the "Palma negra" (*Copernicia cerifera* Mart.) is very abundant. Its wood is exceedingly hard and durable, and much used for building purposes. The fruit of this palm is a large cluster of one-seeded berries, and its long roots furnish Carnauba, a well-known drug of commerce.

Another thing in this vicinity which reminds one that he is

within the tropics is the castor oil bean (*Ricinus communis* L.) which grows most vigorously in waste ground, often attaining a height of twenty or twenty-five feet, and producing an abundance of beans. "Castoria" is not to be found in the drug stores notwithstanding. From their utter neglect of this plant, I infer that the Paraguayans do not appreciate the virtues of castor oil. Even the Guarani women, who are great "herb doctors," pass the Ricinus by.

Perhaps, however, the thing which has interested me the most is a plant belonging to my own particular line of study. Few naturalists of North America or Europe can boast of having visited and gathered the Victoria regia in its native home, but that has been the good fortune of your correspondent, for it is quite common in the lagoons of the Paraguay river. To my eye, however, the flowers, although gigantic, have not half the loveliness and none of the delicious fragrance of our aquatic queen, the Castalia odorata. Their very immensity mars their beauty, and what is worse, in the estimation of the collector, the lower part of the calyx and the pedicel are covered with spines, which makes its collection a work of some difficulty. The pads of this monstrous water lily might well serve as a child's boat, for they are often as much as three feet in diameter, with an erect edge some two inches in height. Once, when gathering specimens, I thought I would test the buoyant capacity of the leaves. With much labor, I waded out into the lagoon, and, at considerable risk of a ducking, succeeded in placing a foot upon each of two adjoining leaves. They supported my weight with ease, sinking a few inches only, but not sufficiently to allow the water to run over the rims. So it is entirely within bounds to say that the pads are able to bear a weight of fifty pounds without difficulty.

Cacti are not numerous in this region, though several species occur. One of them is an Opuntia, similar in flower to my old Nantucket friend, Opuntia vulgaris. It is here called the "Tuna," or Indian fig, and grows as high as one's head, with many spreading branches, and bearing an orange-colored fruit as large as a hen's egg. Two species of Cereus, with beautiful large silvery flowers, are also found. One of these, which has a thick trunk protected by many rows of formidable spines, is columnar, often attaining a height of twenty feet or more, and sometimes splitting into several upright branches, which remind you of the pictures of the old Roman candelabra. This is occasionally used for making

hedges. Still another form is a genuine tree cactus, or, at least, it has a trunk looking exactly like that of a smooth tree, and throws out limbs from the top in arborescent fashion. It seems to be an Opuntia, as it has the flat lobes and the flowers and fruit of that genus.

I notice a number of Agaves, with towering flower stems from fifteen to twenty feet in height. I know that it is said that the Agave plant dies after flowering once. That may be so with what we call at home the Mexican Agave, which is frequently cultivated here, and which I have not seen in flower, but I am strongly inclined to think that it is not the case with another species which is a native of Paraguay, and plants of which I often see in flower. I am sure that I have seen, more than once, living plants with the withered stalks of last year's flowers upon them. I do not think that I can be mistaken in calling this an Agave, as it has the tall spike and the peculiar flowers and fruit of that genus. However, I do not wish to be dogmatic upon the question, and leave the matter for further investigation.

Yuccas are numerous, some of them quite diminutive and others which thrust their radiating spear-like leaves over an area six or eight feet in diameter, and throw up a flower stalk of equal height. Akin to the Yucca, at all events in general appearance, if in no other point, is a very striking plant which belongs to the Bromeliaceæ (possibly Bromelia Caraguata, as some botanists name it). The native Guarani name of the plant is "Caraguata," and many of the common people, who seem to recognize its affinities intuitively, call it the "wild pine-apple." This has numerous long and stiff dagger-like leaves, with hooked spines on their edges, and in its center a rosette of brilliant scarlet foliage, which can be seen for a long distance. The flowers are white, on a thick caudex, at length producing a huge bunch of fig-like fruit, which remind one, indeed, of the pine-apple, but are by no means sweet and luscious to the taste. The brilliant coloring of the leaves disappears altogether after flowering, and nothing remains of it in the dried specimens. Mr. Ball ("Notes of a Naturalist in South America," p. 210) calls this a plant peculiar to the Chilian flora, but he is mistaken, as it is equally common in Paraguay, and has long been known to the inhabitants as one of the many wild plants which can be used in the manufacture of textile fabrics. The fibers of the leaves, when properly treated, split into fine threads, forming an excellent material for cordage and

cloth. Like the "Chacuar," which is either the same or a similar species that grows in the Chaco australis, its threads have been employed by the Indians from time immemorial for making various articles, such as garments, cords, fishing-nets, baskets, and even coats of mail, which are said to be impenetrable by arrows. Several other species of the same family are found here, all of which can be used for the same purposes. One of these, which I have collected, grows upon ledges of red sandstone, and has a tall scape of flowers with scarlet bracts and calyx and bright blue petals.

Of forest trees it may be said that no pine, oak, ash, hemlock, spruce, hickory or maple is known to occur in Paraguay, but the country produces many interesting and valuable woods. With few exceptions they are very compact and durable, and susceptible of a fine polish, but they are generally too cross-grained, knotty and tough to serve for house-timber. Beams made of them are as heavy and solid as iron. The Quebracho colorado, for instance, which is often used in building railroad bridges, furnishes timbers which will support enormous weights and last for years, but the wood is so hard that it can scarcely be cut with a knife. These woods serve admirably for cabinet work, and especially for the turning-lathe. I have seen beautiful cups, goblets, card baskets, and other ornamental objects turned from them, and for veneering many of them are not surpassed in grain, color, delicate markings, and susceptibility of polish by mahogany, black walnut or birch. Among the handsomest trees which I have met is the "Timbo" (Enterolobium timbosa), which grows sometimes to the height of seventy-five or a hundred feet, with wide-spread and symmetrical branches, and long, pinnate leaves, forming a very ornamental shade tree. The wood is employed in making boats and canoes, but not otherwise good for much as timber. Half a dozen other species of Enterolobium, all inferior to the Timbo, grow in the Paraguayan forests. Another, but much smaller tree, common in this vicinity, is one of the mulberry family (Broussonetia probably). This has an umbrella-like head of large, drooping, palmate leaves that are smooth and shining above, and silvery woolly beneath, and presents an appearance quite as striking to the eye as the palm. Its flowers are diœcious, both the staminate and pistillate, in long, finger-shaped spikes, densely packed together upon a common cylindrical receptacle.

The best wood for furniture and all kinds of house-finish-

ing is furnished by the tree here called the cedar. It is light, straight-grained and red at the heart like our North American savin. Strangely enough, however, it belongs to the mahogany family (Cedrela Brasiliensis), but, unlike its congener, it is a soft wood comparatively.

Asuncion, Paraguay.

BRIEFER ARTICLES.

Abnormal roses.—Freaks are not rare among roses. In the GAZETTE, Vol. IX, p. 177, W. W. Bailey mentions "a garden rose in which, in the center of the rosette of petals, was a perfect but unopened bud." E. B. Harger, Vol. X, p. 214, notes that "on a common double climbing red rose" appeared "a sprout on which grows a whorl of four bracts subtending a cluster of ordinary petals, giving the appearance of a stem growing through the center of the rose." Further examples in this line of variation may be worth noting. A rose-bush on our campus has for the past five years produced only "single" roses and in scanty quantity. Last year the plant was divided at the roots into six parts and transplanted. Early in June, a little more than a year having passed, there appeared an abundance of dark red, velvety, double roses which challenged the admiration of every passer-by. Many of these roses exhibited a peculiar freak. One-third of the whole number showed variations. On one bush were six or seven with the stems produced through the center of the flower. In one case the stem developed two perfect expanded leaves, two leaf buds and a flower bud, all immediately above the original rose, which was itself large and beautiful. In another instance the result is a "head" of five unopened flower-buds, each showing calyx, corolla and pistils. Other specimens show one, two, three and four of these "secondary" flowers above the roses proper. The principal flower in each case has its sepals and petals in natural condition; the stamens wanting or appearing as modified petals, while the pistils are entirely replaced by the new stem growth which rises an inch or more above the primary rose.—C. B. ATWELL, *Evanston, Ill.*

Dr. A. B. Ghiesbrecht.[1]—The Mexican journal, *La Naturaleza*, has published a graceful tribute from the pen of a native botanist to the services of a Belgian explorer of the flora of his adopted country. For the career of a traveling naturalist Dr. Ghiesbrecht was well equipped physically and by preliminary studies at the universities of Brussels and Paris. Associated with Linden and Funk in the commission appointed by the Belgian government in 1837 to investigate the botany and zoology of

[1] Vida y Trabajos del Naturalista Belga Augusto B. Ghiesbrecht, Explorador de Mexico, por el Sr. D. José N. Rovirosa.

Mexico, he proved himself a worthy successor to Sessé, Mociño, Cervantes, Humboldt, Bonpland, La Lave, and Lexarza. Braving the hardships and exposures of travel in wild and unhealthy regions, undaunted by shipwreck, robbed and wounded by brigands, involved in the strife and wars of contending factions, he pursued for thirty years the work of collecting plants for the herbaria and gardens of Europe and America. Captivated by the novelties of a tropical flora, his earliest and latest field of research, and apparently his favorite one, was the southeasternmost part of Mexico, comprising the states of Tabasco and Chiapas. But from 1840 to 1855 he devoted himself to the interior and other states, crossing the Gran Cordillera three times from ocean to ocean, traversing the Gran Mesa, and ascending the volcanoes of Colima, Jorullo and Cempoaltepec. The number of plants that he has distributed to herbaria or introduced into cultivation must be immense. Their citations abound in the literature of tropical North American botany. M. DeCandolle refers to a series of exsiccatæ in the possession of Cardinal Haynald, at Colocza, Hungary.

A list is given by Prof. Rovirosa of many notable new species, with which the name of Ghiesbrecht is connected; and to this list might well have been added the remarkable arboreous Scrophulariacea, Ghiesbrechtia grandiflora, which served Dr. Gray as occasion to dedicate a new genus to its discoverer. This tree, known in herbaria only by the originals of description collected in Chiapas, has recently been met with by Baron von Türckheim at Santa Rosa, in the Verapaz highlands of Guatemala.

The memoir concludes with a pleasing account of its subject in his eightieth year at his home in San Christobal Las Casas, where he has resided since 1862: "Retired from the wandering life that he pursued for so many years of the middle part of this century, but still vigorous and active, he occupies himself chiefly wfth horticulture and with doing good to the most helpless class of the community, that he has adopted as his own. His medical services are ever at the call of those that suffer; his moderate means suffice, nevertheless, to bring bread to the door of many a needy one; all his actions reveal to those around him, that he, who has read the great book of Nature, has learned to know the duties that bind him to his fellow men. Proud, then, are the people of Chiapas to have him dwell in their capital, and to call him their countryman, as all of us should do who love the advance of science in Mexico."

The example of such a life is not without influence, and to it in some measure do we doubtless owe the botanical collections now being made by Prof. Rovirosa in these localities.—JOHN DONNELL SMITH.

Indian snuff.—In Lloyd's *Drugs and Medicines* of North America several species of Anemone are described and their properties discussed, but the species mentioned below are not included. It is to be greatly deplored that the welcome quarterly parts of that work are not now issued.

In the Northwest the Indians are familiar with valuable remedies for

many diseases. These remedies are all to be found in the varied flora of that great region. I have been shown recently specimens of "Indian snuff," much used by the Indians of the Rocky Mountain regions for nasal and related forms of catarrh. Two plants here go by the appellation of "Indian snuff." One is Anemone cylindrica and the other is Anemone multifida. The leaves of the plants are the part used. These are gathered before the seeds are quite ripe. They are dried and reduced to a fine powder. This powder is used just as the snuff of commerce. It produces quite a stinging sensation, makes the eyes water, and taken in sufficient quantity induces violent fits of sneezing. When these unpleasant effects have subsided, the throat and nostrils of affected persons become free and have a "comfortable feeling." The leaves are also broken small and smoked, as cubebs, and the smoke is expelled through the nostrils for the same purpose. The juice of fresh leaves is hot to the taste, and is sometimes rubbed into the nostrils instead of "snuffing."—F. W. ANDERSON, *Great Falls, Montana.*

EDITORIAL.

THE GAZETTE has again and again spoken of the importance of an investigator consulting the literature of the subject that he is at work upon. There is still such a crying need of this sort of application that at the risk of being tiresome we propose to speak of it again.

The establishment of the agricultural experiment stations has put upon many the necessity of performing some kind of experimental work who have either had little previous training in such work, or are mentally not adapted to it. Professor Sanborn says truly:[1] "I may say, speaking of the experiment stations, that many of us will always be more or less imitators. There are but very few original thinkers and workers. * * * * The majority of men take some problem partly solved and work along that line. There are very few men in this country that lay out original lines, but these few have plenty of imitators." Now it behooves those who are following some line suggested by another's work, and especially those who are taking the partly solved problems and working at them, to know *accurately* what has been done before. For the failure to find this out two excuses are given; first, that the literature is not accessible; second, that the busy experimenter has not time. The first is somewhat of a justification; the second is utterly puerile. The difficulty caused by the inaccessibility of literature is to be overcome in two ways. In equipping the stations the library should be considered as indispensable as the laboratory. "Jahresberichts" and similar summaries *must be*

[1] At the second annual convention of Agricultural Colleges and Experiment Stations; Proceedings, p. 59.

provided if possible. If, for any reason, this is not done, the investigator must find out where such systematic abstracts can be consulted, and, either by personal visitation or by hiring some one to examine them, discover what has been done.

It is a fair presumption, and one that ought always be made in the absence of knowledge to the contrary, that every subject has been worked at before by somebody, and no one is justified in publishing a piece of work until he has assured himself that what he is about to publish contains something worth setting forth.

Such a position as this does not preclude the publication of bulletins of information by the experiment stations, for a vast deal that is well known to specialists is not known at all to those whom it would directly benefit. It *does* preclude the publication of detailed experiments on ground already well trodden, unless these approach the matter in some new way or point to some different conclusions.

CURRENT LITERATURE.

Minor Notices.

PROFESSOR E. S. GOFF has prepared a paper on the Noxious Weeds of Wisconsin, which forms Bulletin 20 of the Agricultural Experiment Station.[1] It contains a copy of the weed law of the state, which requires the destruction of the following plants under penalties: Cnicus arvensis, Arctium Lappa, Chrysanthemum Leucanthemum, Linaria vulgaris, Xanthium strumarium, Sonchus arvensis and Rumex crispus. Descriptions and illustrations of all except Sonchus arvensis are accompanied by illustrations of several other bad weeds which are not included in the law.

NOTHING DOES MORE to stimulate study of any group of plants than providing beginners with suitable keys for the determination of the plants that they collect. Professor Underwood and Mr. Cook are about to issue a century of illustrative fungi, and they have prepared a series of keys to the genera of the Basidiomycetes and Myxomycetes to accompany the set.[2] These certainly must prove extremely helpful to those for whom they are intended. Of the specimens, fifty nine are Basidiomycetes, twenty-six Ascomycetes, eight Phycomycetes and seven Myxomycetes.

PROFESSOR BAILEY has been conducting a series of careful experiments on the germination of seeds, the results of which are embodied in

[1] Pp. 27, figs. 14. Published by the State.

[2] UNDERWOOD, L. M. and COOK, O. F.—Generic synopses of the Basidiomycetes and Myxomycetes. pp. 21. The authors, Syracuse, 1889.

Bulletin 7 of the Cornell Experiment Station.[3] His conclusions as to the relative influence of constant and variable temperature on sprouting seem to us invalid on account of his apparent failure to take account of the limits of temperature for the germination of the various species of seeds used. His conclusions are essentially those of Köppen (1870), and are open to the same objections. They are contradicted by those of Pedersen[4] who found that when the temperature variations were confined to certain limits the growth seemed to be greater rather than less. His further experiments, however, showed that the temperature variations *as such* exercised no influence.

The most remarkable results are those regarding the influence of the amount of moisture on sprouting. A much larger percentage of seed germinated when the soil was kept drier than usual in greenhouses. In some cases the difference amounted to nearly fifty per cent. The best results were obtained when the soil was kept merely moist.

The other results regarding the influence of soaking before planting, soil, color, latitude, etc., are unimportant. The conclusions as to influence of weight and light accord with those of other earlier observers. Perhaps the most important feature of the bulletin is the insistence of the author upon the inadequacy both of limited testing and field planting to determine the quality of seeds, points that his researches abundantly confirm.

OPEN LETTERS.

Some Nebraska grasses.

Nebraska furnishes a new locality for two grasses which are attributed to the far southwest. *Melica Porteri* Scrib., credited from Colorado to Arizona, was collected in 1887 at Weeping Water, about thirty-five miles east of here, and within fifteen miles of the Missouri river. The second and more interesting find is *Eragrostis pilifera* Scheele, at Valentine, just west of the 100th meridian and at the extreme northern border of the state. Vasey's catalogue says it belongs down in Texas and Arizona. What is it doing way up here? E. pilifera seems more like either Molinia or Catabrosa than Eragrostis. The spikelets are 2-4 flowered. In a three flowered spikelet, the lower flower is hermaphrodite, the second male, and the third sterile, with sometimes a pedicel projecting beyond it. If E. pilifera is to be considered as a true Eragrostis, Molinia should also be made a section of that genus.—JARED G. SMITH, *Lincoln, Neb.*

[3] BAILEY, L. H.—On the influence of certain conditions upon the sprouting of seeds. pp. 31-71, figs. 7. Ithaca, the University, July, 1889.

[4] Arbeiten bot. Inst. Würzburg, i. 563.

NOTES AND NEWS.

THE REV. M. J. BERKELEY, the distinguished English cryptogamic botanist, is dead.

PROF. F. H. KNOWLTON is collecting fossil plants in western New Mexico, Arizona and California.

A BIOGRAPHICAL sketch of the late Heinrich Gustav Reichenbach (1823-1889) is published in *Journal of Botany* (July).

AN ACCOUNT of the botanical work done at the Toronto meeting of the A. A. A. S. will be given in the October GAZETTE.

W. W. CALKINS has gone on a trip to the mountains of East Tennessee, and will not let any lichens slip through his hands while away.

PROFESSOR E. L. GREENE spent the summer months in an exploration of the forests of Colorado, Montana, Oregon, Washington and California.

ERWIN F. SMITH is investigating peach yellows in Michigan, and before his return to Washington will visit the principal peach-growing regions of the east.

MR. M. B. WAITE is investigating pear blight, especially in its relation to the Le Conte industry in the south, under the direction of the section of vegetable pathology.

IN HIS NOTES on the synonymy of Cladrastis tinctoria, in a recent number of *Garden and Forest*, Dr. C. S. Sargent announces his adherence to the principle of the maintenance of the earliest *specific* name.

DAVID G. FAIRCHILD, a graduate of the Kansas Agricultural College, and a special student of Dr. Halsted, has been appointed an assistant in the section of vegetable pathology in the United States Department of Agriculture.

AMONG SHORT-LIVED seeds those of some of the willows are remarkable. Woloszczak finds that the seeds of Salix pentandra live only forty-eight days. Wiesner found those of S. purpurea viable for only eighty-five days.

DR. GEO. VASEY is making a tour through the west for the purpose of selecting sites for several additional grass stations. He will visit Kansas, Colorado, California and several other states, returning to Washington about the first of September.

FRANK S. EARLE, of Mississippi; Prof. E. S. Goff, of Madison, Wis.; and Prof. L. R. Taft, of the Agricultural College of Michigan, have been appointed special agents in the section of vegetable pathology of the United States Department of Agriculture.

DR. A. ENGLER has been called to the University of Berlin as professor of botany and director of the Royal Botanical Gardens. If he accepts, a worthy successor to the distinguished Eichler will have been secured. Dr. Urban has been nominated as assistant director.

M. V. FAYOD contributes a monograph of over 200 pages, entitled Historie naturelle des Agaricinés, to the *Annales des Sci. Nat.* (*Bot.*). The comparative anatomy and development of these fungi is described at length. A grouping of all the known genera, with descriptions of their characters and critical remarks forms about half of the monograph.

DR. DOHRN, the director of the zoölogical station at Naples, appeals to all algologists to send to the station copies of papers relating to algæ, as the basis for a library for the assistance of the botanists who avail themselves of the privileges of the station. In the new building which is being erected additional accommodations will be provided for botanical work.

DRS. LEHMAN AND MORI, in a recent paper[1] collate the literature and experiments as to the poisonous nature of the seeds of the common corn cockle, *Agrostemma Githago* L. These show that the fresh seeds are highly poisonous, but that they become entirely innocuous after roasting. The authors suggest that these seeds would form a very useful food for domestic animals.

THE BULLETIN of the Royal Gardens, Kew, has done a great service to botanists in giving (No. 31, July, 1889) a guide to the botanical literature of the British Empire. It was suggested by the fact that "Kew is often called upon to answer questions, on the shortest notice, concerning the vegetation of some remote part of the world, and the best books to consult on the subject; hence the idea of preparing a concise guide."

NEWTON B. PIERCE, who has been doing special work with Prof. Spalding, at Ann Arbor, for the past two years, has been commissioned by the Secretary of Agriculture, to visit California for the purpose of investigating a "mysterious" grape disease which appeared in that state three or four years ago, and which has already destroyed many thousand vines. His work will be carried on under the direction of the section of vegetable pathology.

FROM AN examination of the anatomical structure of the pitchers of Sarracenia Drummondii, E. Heckel comes to the conclusion that it represents a hollow petiole, and the operculum the lamina of the leaf. The resemblance in structure is very close to the petiole of Nymphæa alba, and the near affinity of the Nymphæaceæ and Sarraceniaceæ can not be doubted. The structure and arrangement of the vascular bundles are very similar. The parenchyma of the petiole of the water-lily contains large numbers of air-cavities lined with hairs. These appear to be fused in Sarracenia into one large central cavity, the cavity of the pitcher, in which we again find the hairs which prevent the escape of the captured insects.—*Jour. Roy. Mic. Soc.*, June.

MR. L. MAGNIN strongly recommends[2] iodized phosphoric acid to replace the iodized chloride of zinc as a reagent for cellulose. Those who have used the latter are well aware of its shortcomings in the way of difficulty of manufacture and slowness of action. The new reagent is said to act almost instantly or within a few minutes. To prepare it take pure glacial phosphoric acid, add one-fourth to one-third of its bulk of distilled water, and then some crystals of potassic iodide and iodine until the mixture becomes of a sherry brown. In using this reagent with cellulose walls in which the presence of other matter is suspected, it is well to warm the section in a one per cent. solution of HCl or a four per cent. solution of KOH, in case the coloration does not appear promptly. The author also recommends iodized chloride of calcium and chloride of aluminium.

[1] Archiv für Hygiene, ix. 257.

[2] Bull. Soc. Bot. France, XXXV. 421.—*fide J. R. M. S.*

THE PUZZLING and much-debated question regarding the nitrogen assimilation of plants has been receiving much attention during the last few years. In all the discussion the behavior of the Leguminosæ cuts an important figure. Recall the references in this journal recently to papers on the root-tubercles of these plants. The publication in November, 1888, of a paper by Hellriegel and Willfarth seems to have given fresh impetus to the study and discussion of this interesting problem. The conclusions reached by these experimenters (continuing Hellriegel's earlier researches) were essentially these:

The Leguminosæ differ markedly from other plants (particularly grasses with which they were compared) in their N assimilation, since the latter depend entirely on the N in the soil for their supply, while the former have an additional source in the free N of the air. This they are enabled to utilize, not by any power of their own, but through the low organisms (as to whose nature nothing is decided) which enter into symbiotic relations with the roots, and thus give rise to the tubercles. These tubercles are absent from the roots of Leguminosæ grown in sterilized soil, and are formed when to such soil a small quantity of an infusion of unsterilized soil is added. Plants from which such tubercles are absent can not assimilate free nitrogen.

These conclusions as to the great difference between the N assimilation of Leguminosæ and other plants are strongly controverted by Frank[3], who points out that Joulie, in 1885, determined the fixation of free N by ray grass and buckwheat, while he himself has demonstrated the same for some of the simple algæ. He adds details of recent experiments with oats showing a like N accumulation. In the experiment with oats the N in the soil was at the beginning 0.118 per cent. After raising nineteen strong plants, bearing 530 ripe seeds, analysis showed 0.131 per cent. in soil. This increase was probably due to refuse from the plants, such as the root-hairs and finer rootlets. The N in the seed sown was 0.0142 gm.; in the crop, 0.487 gm. In a vessel containing the same quantity and quality of soil treated in the same way, but having no plants in it, the percentage of N at the conclusion of the experiment was 0.110. Hellriegel's negative results Frank ascribes to the lack of vigor in his culture plants, and asserts that plants will not assimilate N from either soil or air unless they are strong and healthy. He also claims at length the absence of exact proof that the root-tubercles of Leguminosæ are organs of assimilation. Hellriegel's case on this point rests on the observation that among peas grown on a soil free from N some starved, while others subsequently recovered and grew well. In subsequent experiments this recovery was hastened by watering the plants with a minute quantity of an infusion of field soil. From this Hellriegel infers that the peas were unable to assimilate the free N until tubercles were formed by the infection of the roots from the infusion, after which the plants grew well. Frank, however, interprets the experiment to mean that the peas were unable to assimilate free N because they could not, under the conditions, attain sufficient vigor. He further argues *a priori* against the probability of Hellriegel's theory, and shows the dissimilarity between the root tubercles and mycorhiza, with which they have been compared.

[3] Ueber den gegenwärtigen Stand unserer Kenntnisse der Assimilation elementaren Stickstoffs durch die Pflanze.—Ber. d. D. bot. Gesells., vii. 234.